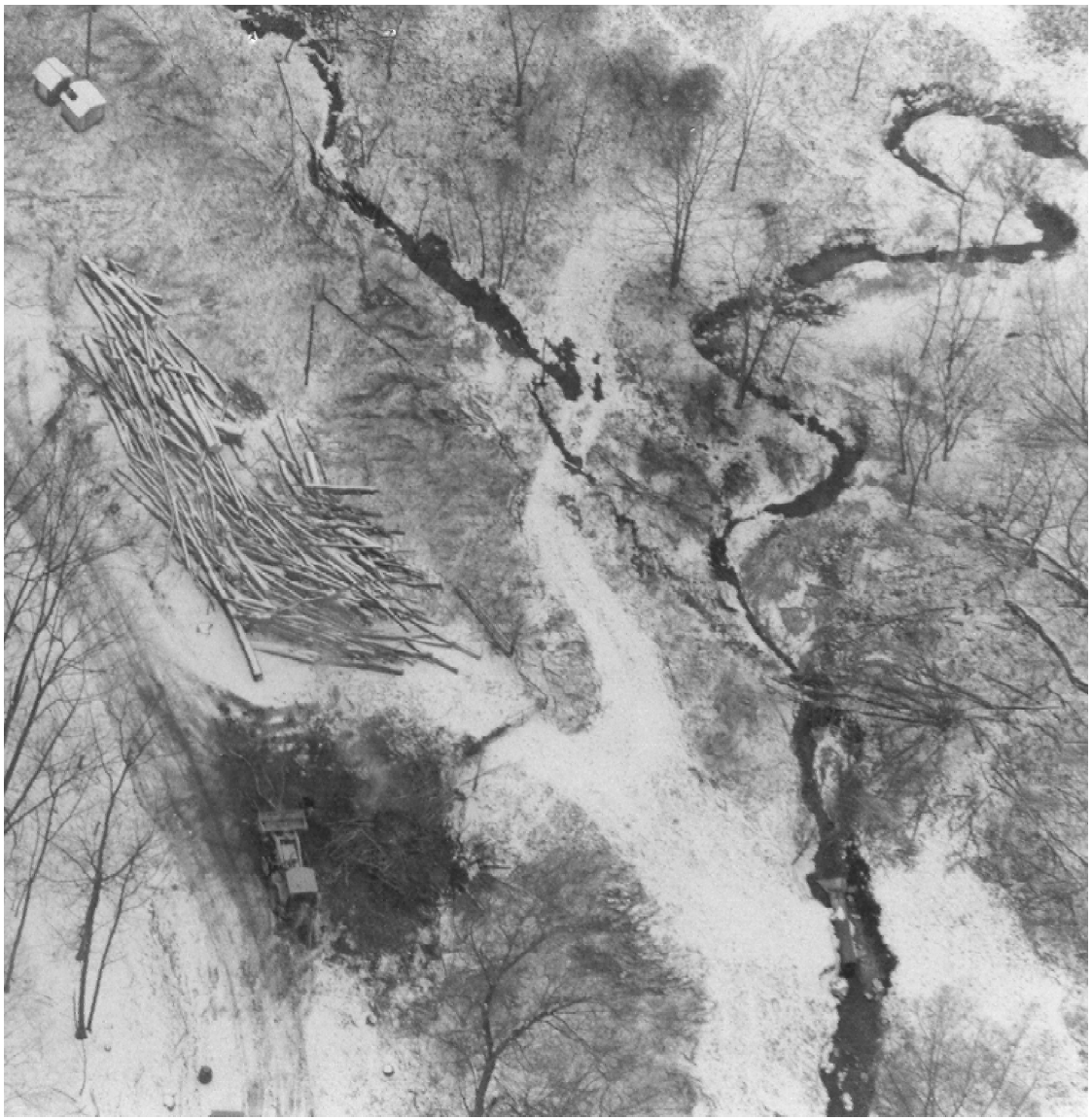
2003 BMP Monitoring Report

County Forest Ownership
State DNR Ownership

Wisconsin's Forestry Best Management Practices for Water Quality



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Acknowledgments

Foremost, the hardwork and cooperation of the County and State field foresters enabled 2003 monitoring. Their support and commitment ensures Wisconsin's effective, voluntary program.

The BMP Advisory Committee should be specially acknowledged for their enduring, visionary work. Effective collaboration between stakeholders has resulted in a productive, proactive BMP program.

Dale Gasser, Forest Hydrologist for the DNR Division of Forestry, built the 2003 monitoring schematic at the Advisory Committee's request. His tireless commitment to BMP training, administration and fieldwork is appreciated.

Hundreds of hours of field-checking, training, GIS programming and writing were conducted by Kyle Holland. His work and the work of countless other DNR staff afforded the monitoring teams the efficiency necessary to complete their inspections in a timely manner.

Monitoring team members – which included team leaders Colleen Matula, Brooke Ludwig and Jim Mineau – contributed a significant amount of time traveling to and monitoring sites. The names of all team members are included as Appendix A. Their reputable fieldwork and methodical evaluation are critical to the creditability of this report.

Thanks also to the county forest administrators, regional foresters, wildlife managers, Paul Rasmussen, Darrell Zastrow and the committed support staff in Madison.

Thank you all who have involved yourselves in monitoring and those that, above all else, are practicing good forestry everyday.

Executive Summary

The past eight years have been fruitful, with significant strides and improvements in Wisconsin's Forestry BMPs for Water Quality program. Several minor revisions of the BMP field manual, multiple years of BMP monitoring and measurable improvements in BMP application are momentous to Wisconsin's voluntary program. It is apparent that forestry BMPs are being applied correctly, more often, and with greater consistency today, than in 1995.

Monitoring conducted in 2003 marks a new approach to Wisconsin's proven BMP monitoring methodology. Within the near future, given the appropriate resources, the BMP Advisory Committee and the Division of Forestry will work together to cyclically sample forest landowner categories. Measurements in sufficient quantity will be obtained and compared to baseline measurements. The hard, conscious efforts of forestry professionals will be documented, as will the success of Wisconsin's voluntary program.

County forest and state DNR lands closed during the calendar year of 2002 were sampled in the fall of 2003 and spring of 2004. Traditional DNR-solicited teams monitored county forest ownership, while a private contractor observed state DNR ownership. A total of 92 person-days were contributed to 2003-2004 field monitoring. Overall, 2003-2004 monitoring indicates empirically significant improvements in BMP application since the program's conception.

Significant Findings

Overall correct BMP application for county forest ownership is estimated to be 93%†, compared to 86%† during 1995-1997. Also, BMP applications for all comparable BMP categories have increased.

The overall correct BMP application rate for state DNR ownership is estimated to be 90%†, compared to 86%† during 1995-1997. BMP applications for the majority of comparable BMP categories have also increased.

Generally, more attention to *forest road* and *skid trail* BMPs should be paid in the future than today, as estimates for these two BMP categories indicate margin for improvement.

Consistent with prior research findings, effectiveness measurements show that most water quality impacts are *long-term* in the absence of BMP application. Therefore, it is imperative that forestry professionals implement water-quality BMPs wherever they are needed.

Future landowner-category monitoring will require sustained support and commitment by forestry field professionals: Today, BMP monitoring documents our voluntary success to water quality protection, which in-turn preserves our voluntary program into the future.

Note:
† *Denotes that data represents timber sales where at least one acre of harvesting occurred on a wetland; was conducted within 200 feet of a lake, river or stream; or a significant length of wetland was crossed.*

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Introduction

Since its beginning in 1995, Wisconsin's program for forestry best management practices (BMP) has significantly evolved. Through comprehensive, statistical monitoring, it is apparent that forestry BMPs are being applied more often, more consistently.

The BMP Advisory Committee is employing a new initiative to effectively document the program's success.[1] In the past, annual BMP monitoring targeted multiple landowner categories: Often, sample sizes were too small to accurately infer estimates for a specific landowner category. The committee developed a multiphase, landowner-category-specific sampling design to address the need for more precise estimates.

As of 2003, forest management activities will be sampled by individual landowner category; one or two categories will be sampled each year. Funneling department resources into obtaining category observations, in sufficient quantity, will ultimately strengthen Wisconsin's BMP program.

Applicable Importance

Clean water is essential to Wisconsin's economy and high quality of life. This water provides a habitat for wildlife, fish and other aquatic life. Our forests play a vital role in purifying and maintaining clean water in the state's lakes, streams, wetlands and groundwater. In addition, forests provide economic, ecological and social benefits such as wood products, wildlife habitat, clean air and recreational opportunities.

Within the context of forestry practices, water quality is degraded from one main cause: nonpoint source (NPS) pollution. NPS pollution occurs when surface water runoff from rainfall or snowmelt moves across or into the ground, picking up and carrying pollutants into streams, lakes, wetlands and groundwater. An example of a NPS pollutant is soil as it erodes and flows into a water resource. Eroded soil, or sediment, is the number one NPS pollutant affecting our nation's lakes, streams and wetlands (US EPA 1992).

There are many land uses that can cause NPS pollution: agriculture, mining, urban and rural development, construction, and forestry. Nationwide, the U.S. Environmental Protection Agency estimates that between 5 and 9% of NPS pollution comes from timber harvesting activities (US EPA 1997). Because Wisconsin is relatively flat, it is estimated that forest practices generate about 5% of the state's NPS pollution. While 5% sounds small and insignificant, localized NPS pollution can be considerable.

EPA Reporting, Clean Water Act

In 1977, Section 208 of the federal Clean Water Act was passed, requiring each state to develop plans and procedures to control "silviculturally related non-point sources of pollution...to the extent feasible." Section 319 of the 1987 federal Water Quality Act further required each state to develop and implement a program to reduce NPS pollution to the "maximum extent practicable."

The Forest Service, EPA and other federal agencies may use BMP monitoring results.

Affirmation of Voluntary Status

It is important to recognize the strong, voluntary nature of Wisconsin's Forestry BMPs. Most states in the U.S. either have a regulated forestry BMP program with forest practice legislation or a voluntary forestry BMP program with water quality regulations (NCASI 2001). Regulatory programs are far more expensive to implement than voluntary programs (Ice and Nettles 1999). The Wisconsin DNR encourages the use of BMPs through, in-part, education and training.

[1] For more information on Wisconsin's Forestry BMP Advisory Committee, consult *The 2002 Statewide BMP Monitoring Report* (Breunig, Gasser and Holland 2003).

➲ Case Study

Gardner Lake Sale

The Gardner Lake timber sale, located in Washburn County, is a good example of challenging BMP design and implementation. Numerous water features – including lakes, ponds, wetlands and muskegs - are adjacent to the Gardner Lake sale area. Soil samples and habitat assessments indicted the presence of moderately erodible soils and diverse natural communities. As such, special considerations were given to forestry BMPs.

Washburn County foresters and loggers provided functional buffer strips and riparian management zones to protect water quality. Additionally, the selection of long-lived species and seasonal harvesting constraints served to protect and enhance the unique ecosystems.

Appropriate planning, design, communication and implementation of BMPs are essential for every timber sale, statewide.

A voluntary BMP program, along with existing water quality regulations, will have the greatest success in protecting water quality during forest management activities, at the least possible cost. BMP monitoring has proven and most-likely will continue to prove the effectiveness of the voluntary program.[2] Sustained, positive monitoring results ensure that Wisconsin's BMP program will remain voluntary.

Forest Certification

The Sustainable Forestry Initiative®, American Tree Farm program and Forest Stewardship Council embrace the principles of social, economic and ecosystem sustainability through appropriate planning and effectively-applied forest management. Forestry BMPs, training and monitoring strengthen Wisconsin's forest products industry and help ensure that the high ideals of forest certification are being met.

Education and Outreach Needs

Upon completion of BMP monitoring, results are analyzed and interpreted by a committee of experts. The committee makes recommendations to strengthen BMP training, conduct regional outreach, or target landowner categories for educational activities.

Investing state resources into the most critical spatial and social educational opportunities will ensure continued and improved forestry BMP application across the state.

[2] BMP application on state managed lands is not voluntary.

BMP Modification

Monitoring results may indicate specific BMPs that are being applied correctly and are not effective in mitigating NPS pollution. These BMP guidelines may be modified or omitted from the BMP field manual. In 2002, the BMP Advisory Committee created guidelines for the revision of the BMP field manual (Appendix B). Field manual users, water quality experts, the BMP Advisory Committee and the State Forester review suggested revisions before they are adopted.

Field Education

During actual field monitoring, forestry professionals learn how to better employ forestry BMPs to improve water quality. Loggers, foresters, landowners and resource managers familiar with selected BMP-monitoring timber in BMP monitoring. Trained BMP monitoring teams evaluate the application of BMPs, in-turn providing constructive education.

Multiphase Monitoring

Starting in 2003, sufficiently-sized samples from one or two landowner categories will be randomly selected each year (see Table 1). Tribal lands will not be sampled due to their exclusive position under the Clean Water Act. Previous sampling on tribal lands indicates that tribal nations are applying BMPs at or above normal levels.

It is planned that federal forest and private industrial lands prior will be sampled over a one-year period, prior to 2008. In Wisconsin, federal forestlands are exclusively national forests, while private industrial lands are managed primarily for economic goals focused on fiber production.

A minimum sample size of 20 timber sales will be required from each landowner category to achieve statistical significance within 10% of the true mean (95% confidence).

As planned, non-industrial private forest (NIPF) lands will also be sampled prior to 2008. The number of NIPF timber sales conducted each year, as well as the documented variation between BMP applications, suggests that more than 60 sales be sampled. Securing landowner permissions for monitoring on NIPF lands requires an unusual amount of effort. Therefore, only NIPF sales will be monitored during their selected year. In 2002, timber sales on NIPF lands were monitored in sufficient quantity to make estimates within 10% of the true mean (95% confidence).

Period to monitor	Year of monitoring	Landowner categories	Sample sizes
Jan 1st – Dec 31st, 2002	2003	County forest	*n*=20-30
		State DNR	*n*=20-30
Jan 1st – Dec 31st	Prior to 2008	Federal forest	*n*=20-30
		Private industrial	*n*=20-30
Jan 1st – Dec 31st	Prior to 2008	Non-industrial private forest	*n*=60+

Table 1: Projected multiphase, landowner category sampling design and sample sizes by year, 2003 and beyond.

The BMP Field Manual

Wisconsin's Forestry BMPs are practical and cost-effective guidelines developed to assist loggers, equipment operators, landowners and natural resource managers in protecting water quality during forestry operations. BMPs for Wisconsin are explained in *Wisconsin's Forestry Best Management Practices for Water Quality: A Field Manual for Loggers, Landowners and Land Managers*. This manual is available free of charge from the Wisconsin Department of Natural Resources, Division of Forestry (WDNR 2003).

Note:
More information regarding nonpoint source pollution, Wisconsin's best management practices program and BMP education and training can be found in The 2002 Statewide BMP Monitoring Report *(Breunig, Gasser and Holland 2003).*

Methodology

Monitoring on county forest lands was conducted by traditional, DNR-solicited teams. DNR-solicited teams were comprised of voluntary, multidisciplinary professionals and forest stakeholders. A minimum sample size of 20 timber sales was required to achieve statistical significance within 10% of the true mean (95% confidence).

To ensure unbiased, credible monitoring results on DNR lands and to compare the costs and benefits of the traditional approach, a private contractor was selected to monitor state forest, fishery, wildlife, and park areas. Both the professional teams and the contractor were calibrated at BMP monitoring workshops.

The previous methodology for monitoring BMPs was followed, in order to ensure comparable monitoring results between years, landowner categories and BMP categories. The methodology used for 2003 monitoring, as for previous years, included four steps: team member selection, sample selection, monitoring and data analysis.

Objectives

Monitoring was conducted using the following objectives, where each objective was formulated by the advisory committee[3]:

- Determine the extent to which BMPs are being applied throughout Wisconsin;
- Determine the effectiveness of applied BMPs in protecting water quality;
- Determine the effects of not properly applying BMPs where needed; and
- Obtain descriptive information about RMZs and buffer strips with respect to size, vegetative composition and past use.

[3] For more information on Wisconsin's Forestry BMP Advisory Committee, consult *The 2002 Statewide BMP Monitoring Report* (Breunig, Gasser and Holland 2003).

Monitoring Teams

Monitoring involved teams visiting and evaluating timber sales, where at each sale the team determined if and to what extent BMPs were applied. To ensure creditable monitoring results, monitoring teams were comprised of people with a broad range of interests and expertise.

DNR-solicited teams were selected for county forest monitoring and bids were accepted from private contractors for state DNR monitoring. All bidders were required to have a team(s) with appropriate qualification and diversity.

Member Selection: County Forest Monitoring

The Division of Forestry solicited team members from: county, state and federal agencies; the University of Wisconsin Extension; professional forestry organizations; environmental and conservation organizations; professional loggers; forestry consultants; and the timber, pulp and paper industries.

Members were selected to fill three monitoring teams, with about six members comprising each team (Appendix A). Five of the six team members represented forest management, logging, soil, water quality, or an established environmental or conservation organization. The sixth person served as a team leader and was either a DNR forester or Forest Service hydrologist.

Contractor Selection: State DNR Lands Monitoring

The Division of Forestry advertised an open bid for BMP monitoring on state DNR lands. The announcement was listed in several major newspapers, and was also distributed to a precompiled list of contractors supplied by the Minnesota DNR. Twelve bids were received; Northern Environmental was the lowest bidder with the appropriate qualifications. Northern Environmental was awarded the contract at $574.48 per-site.

➲ Case Study

Bear Creek Sale

The precautionary, careful work by the foresters and loggers of the Flambeau River State Forest is apparent at the Bear Creek timber sale, completed in early March of 2002. Access to the sale area required crossing a navigable, perennial stream; foresters and loggers worked together to minimize water quality impacts.

A well placed pole ford was installed and used during frozen conditions. To reduce the risk of stream sedimentation, fill material was not added to the ford crossing. The ford was removed without damage to the stream banks or bed.

Equipment operators retired the access road after the completion of the sale using an earthen berm. The berm, located at the road's entrance, prohibits access to the road, stream crossing and sale area.

Careful selection and implementation of stream crossing structures significantly reduces impacts to water quality.

Calibration Workshops

Calibration workshops were held for both the DNR-solicited and contractor teams. The workshop was designed to meet three objectives: familiarize the team members with the monitoring process, disseminate the design of the monitoring worksheet and calibrate teams.

The training was conducted over a two-day period, where the first consisted of in-class overview and the second of field trips. The calibration workshops were held twice - July and November - and were similar to the 2002 and 1997 workshops.

Sample Selection

Thirty-one county forest and twenty-nine state DNR timber sales were selected for BMP monitoring. Both were sampled in sufficient quantity to ensure precision within 10% of the true mean, at the 95% confidence level.

Determining Sample Sizes

Observations from the 2002 BMP monitoring effort provided variance estimates used to calculate the target sample sizes for 2003. Based on the 2002 pilot sample, the target sample sizes for county forest and state DNR lands were both 20-30 timber sales.

Identifying Sampling Locations

Timber sales were identified using DNR databases. Appendix C is a map of all County Forest and State DNR timber sales closed during the time period of January 1st - December 31st, 2002.

For each landowner category, sales closed during the sampling period were randomly numbered from 1 to *n*, where *n* was the total

number of timber sales closed during the sampling period.

Previous monitoring indicates that between 20 – 30% of selected timber sales actually qualify for BMP monitoring. Therefore, the top 110 prioritized timber sales from each landowner category were selected for field checking.

Field Checking

Field checking timber sales to confirm eligibility requirements significantly reduces the cost of BMP monitoring.

Timber sales were field checked in two phases: Initially, administrative foresters were identified for each randomly selected sale. Administrative foresters are field foresters who likely had knowledge about the administration of the timber sales selected for potential monitoring. Administrative foresters were then directed to a Web site where they could either confirm or deny timber sale eligibility requirements. Fifty-one county sales and forty-seven state sales were eligibility-confirmed during phase-one.

Second, a BMP forester traveled to each of the 98 confirmed timber sales to double-check their eligibility. Thirty-one county sales and twenty-nine state sales were eligibility-reconfirmed during phase-two. The eligibility requirements for 2003 monitoring are listed in Table 2.

Using a combination of "local knowledge" as well as trained BMP foresters yielded an efficient and reliable pool of sample locations. The use of the Internet significantly automated repetitious office work and easily facilitated the distribution of data to field foresters. The Web site was a very effective, consistent tool for conveying the eligibility requirements and was also used to collect valuable information about eligibility-confirmed timber sales.

Eligibility Requirement
1. At least one acre of harvesting was on a wetland;
2. The sale was conducted within 200 feet of a lake, river or stream; or
3. A significant length of wetland was crossed during the harvest.

Table 2: Eligibility requirements for 2003 BMP monitoring. Confirmed timber sales must match one or more of the three requirements.

The field-check Web site was integrated with a live geographic information system (GIS) so that the real-time responses of timber sale administrators could be automatically mapped. The travel time of phase-two field checks was significantly reduced because of accurate, up-to-date GIS maps. Phase-two was started prior to the completion of phase-one because the Web site was automated and was linked to a GIS.

The percentages of timber sales qualified by water feature are illustrated in Figures 1 and 2.

Monitoring

Monitoring on county forest ownership was conducted during September and October. DNR-solicited teams contributed 8 team-days and approximately 48 person-days toward field monitoring.

Monitoring on state DNR ownership was conducted during November and April. The contractor invested 11 team-days and about 44 person-days.

Spatial Distribution of Sampling Points

The spatial distributions of monitored county forest and state DNR timber sales were similar to that of the total population of timber sales conducted during the sampling time period: Many timber sales were monitored in the Northern and West-Central regions of the state, as the majority of timber harvesting activity is located within these regions. The percent distributions of county forest and state DNR sampling locations are described in Figures 3 and 4.

The locations of monitored county forest and state DNR timber sales are illustrated as Appendix D.

Field Procedures

Team leaders received copies of the eligibility criteria forms (field-check forms) for each sale to be monitored, a road atlas, supply of monitoring worksheets and GPS unit prior to monitoring. In most instances, team leaders also received copies of aerial photographs, topography maps, plat book maps, field check maps and timber sale contracts.

Team leaders arranged times and locations to meet with property managers and loggers interested in observing the inspections.

Team members traveled to and observed timber sales as a group. Observation included thoroughly walking the site, examining roads and inspecting stream or wetland crossings. Measurements were taken for slope, basal area and riparian management zone (RMZ) width.

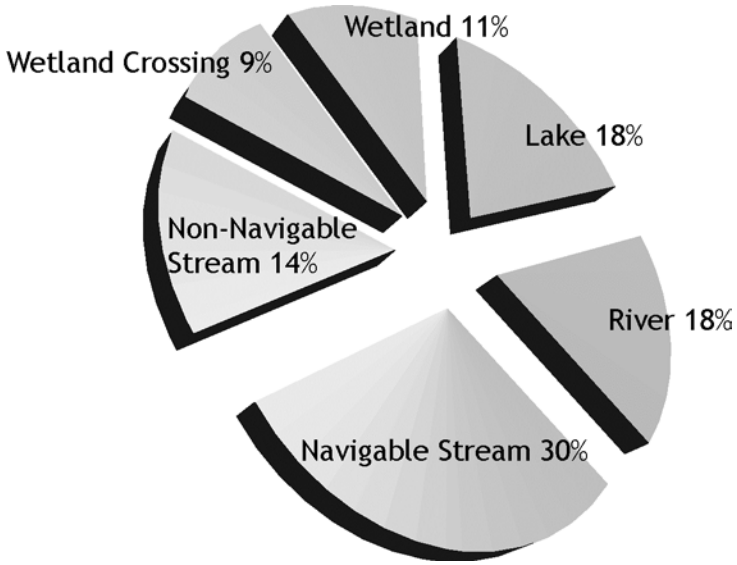


Figure 1: Percent qualification by water feature for state DNR ownership.

A GPS unit was used to collect spatial information, such as the locations of water crossings, excessive rutting, seeps and springs. The GPS unit was also used to track the movement of the teams, for future reference. All GPS data was downloaded at the Division of Forestry headquarters in Madison. The data were later used to produce site reference-maps for potential re-monitoring.

On the first day of monitoring, a BMP program staffer accompanied each monitoring team into the field. The trained staffer established consistency between teams and provided training refreshment, which usually included GPS review.

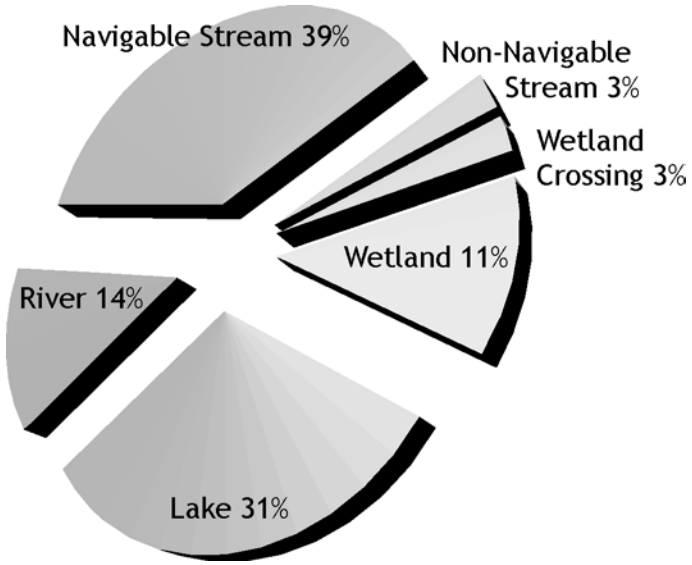


Figure 2: Percent qualification by water feature for county forest ownership.

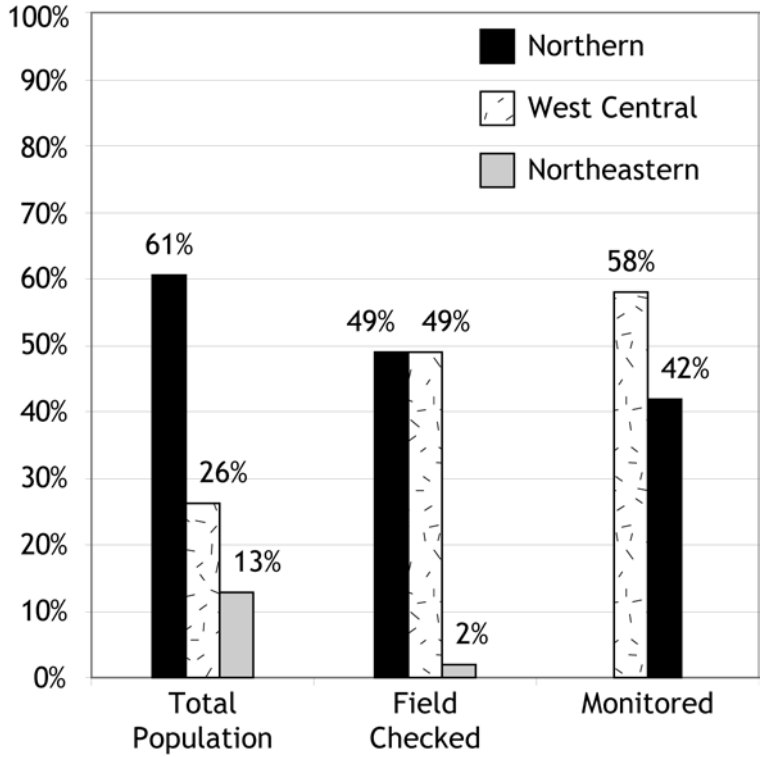


Figure 3: Percent distribution of county forest sampling locations by DNR region. Total population *represents county timber sales closed during the sampling period.* Field checked *represents timber sales field-checked, while* monitored *represents those actually monitored.*

Monitoring Worksheet

The 2003 BMP Monitoring Worksheet consisted of three parts: application and effectiveness rating, supplemental questionnaire and professional judgment rating.[4] To maintain consistency between monitoring teams, monitoring guidelines were included with the worksheet.[5] Lastly, a GPS information sheet was also included with the monitoring worksheet. The information sheet provided detailed, specific directions on how to record waypoints and tracks. Tracks record the route the monitoring team followed while in the field.

[4] The 2003 BMP Monitoring Worksheet was similar to the 2002 BMP Monitoring Worksheet. The 2003 worksheet included as Appendix E of this report.

[5] Monitoring guidelines were also similar to the 2002 guidelines. Appendix F is the monitoring guidelines for 2003.

Single Stage Cluster Sampling

$$\overline{Y} = \frac{\sum_{i=1}^{N}\sum_{j=1}^{M_i} y_{ij}}{\sum_{i=1}^{N} M_i}$$

$$\mathrm{var}(\overline{y}) = \left(1 - \frac{n}{N}\right)\frac{1}{n}\,\frac{1}{N-1}\sum_{i=1}^{N}(t_i - \overline{Y}M_i)^2$$

Single stage cluster sampling is used to statistically measure attributes of random sampling clusters. In the case of Wisconsin's BMP monitoring, BMP guidelines are *attributes* of timber sales. Timber sales are sampling *clusters*. For each attribute, nominal application and effectiveness measurements are made.

Using the equation above, measurements of clusters' attributes (BMP guidelines) are summarized to determine an *estimated mean*. The estimated mean for Wisconsin's BMP monitoring is within 10% of the *true mean* of the population (95% confidence). If all eligible timber sales were monitored, the estimated and true means would be the same. This scenario would be sampling at 100% confidence. However, measuring every timber sale in Wisconsin is not economically feasible, therefore only some are measured.

Variance is calculated similarly and represents the measurable differences between attribute and cluster observations. Variance is used to infer consistency of BMP application and effectiveness.

Answers to unique questions can be statistically inferred by considering different combinations of clusters and cluster attributes. Statistical sampling provides solid information for decision-making.

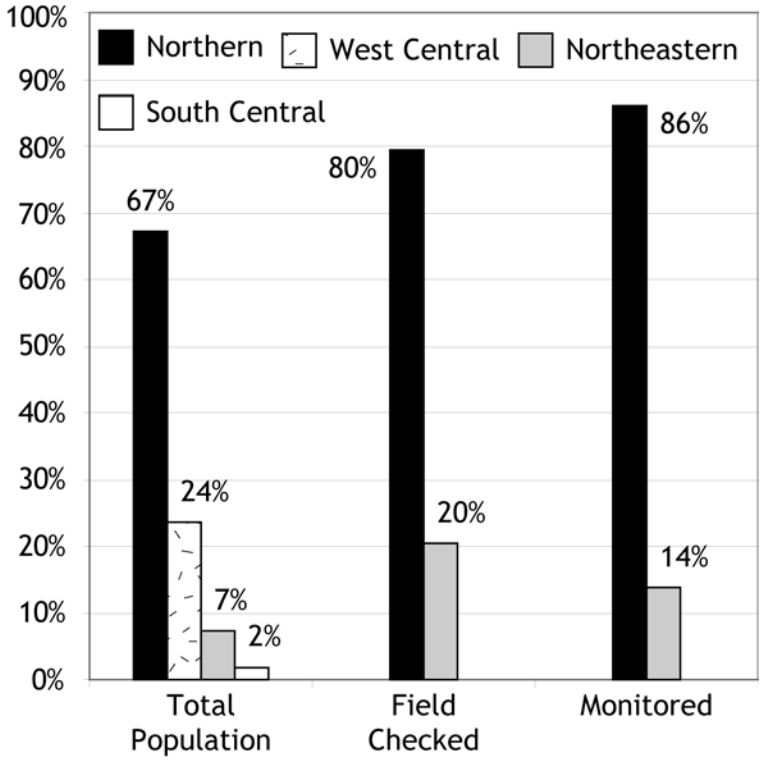


Figure 4: Percent distribution of state DNR sampling locations by DNR region. Total population *represents state timber sales closed during the sampling period.* Field checked *represents timber sales field-checked, while* monitored *represents those actually monitored.*

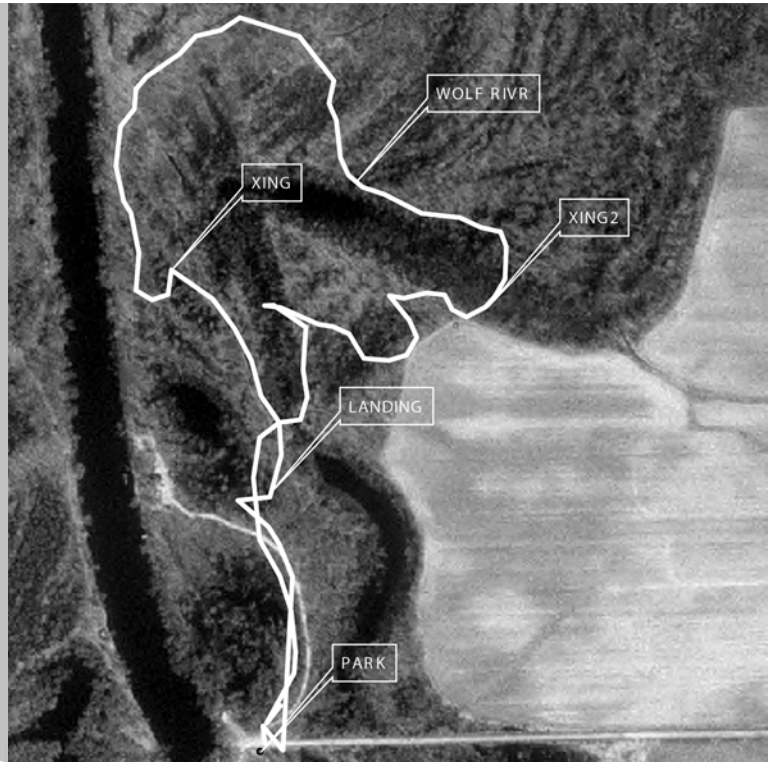
The worksheet was filled-out onsite or relatively soon after visiting the site. Only the monitoring team members were allowed to fill out the worksheet. One worksheet was filled out per site, requiring that consensus be met before finishing. Team members marked appropriate responses for application and effectiveness ratings on the right-hand side of every page. Ratings for effectiveness were only recorded where application ratings were other than zero or four, *not applicable to site* or *insufficient information to rate*, respectively. Effectiveness ratings were qualitative. Team members were also strongly encouraged to supply comments with their ratings.

BMP Data Analysis and Geographic Information

Several technologic innovations aid the Division of Forestry in complex data analysis and visual interpretation of BMP monitoring data. In-house, custom software applications enable quick and efficient data entry, simplified analysis scripting and GIS integration of monitoring data.

Monitoring data formally residing in Paradox datasets have been simplified and made more accessible in Access databases. Custom applications for Visual Basic enable GIS and Excel users to quickly explore possible BMP trends. DNR geographic information systems can be accurately integrated with BMP datasets and estimates using the custom BMP software.

Field data, collected on paper and GPS units, can be integrated to document timber sale observations as GIS-produced maps.



Supplemental Questions

Supplemental questions were included at the end of the worksheet. Questions were asked about site management, conditions, water resources and timber harvest. Questions were fairly objective and were filled out collectively by team members.

Professional Judgment Ratings

Professional judgment ratings were recorded for every site, decided jointly by team members. Also referred to as *overall ratings*, these responses were only used to generalize the application and effectiveness of BMPs on any particular site. This generalization was only used to inform property managers how their sale scored during the inspection. These ratings held no statistical significance and were not used for estimations within this report.

Data Analysis and Inference

After completion of field monitoring, DNR staff entered the data into a Microsoft Access database for storage and analysis. Both Division of Forestry and Bureau of Integrated Science Services staff analyzed the data.

Since a number of attributes were collected at each site, and the number and type of attributes differed between sites, the sampling design was a *single stage cluster sample* (each sale was a cluster). The same sampling design was used in all previous studies. Variance estimates and confidence intervals were calculated using the methods outlined in Cochran (1977).

There were several limitations and opportunities for bias in the sampling methodology. These bias and limitations are described as Appendix G.

Results

Mean estimates for BMP application by BMP category and region were calculated for each landowner category.

Overall mean estimates of water quality impact were calculated for each landowner category, as well as for selected BMP categories.

Several logarithmic regressions were implemented to infer relationships between the locations and application observations of sampling clusters. Regressions indicate where BMP outreach and education activities can be enhanced.

Statistical Notation

A *p* value and a 95% confidence interval are used to summarize statistical results. A *t-test* was used to compute *p* values:

➲ When $p \leq 0.05$ there is a significant difference between the two values being compared; when $p > 0.05$, there is no statistically significant difference between the two values being compared.

➲ A 95% confidence interval denotes that we are 95% confident that the true estimate is within the interval. For instance, "44% (± 25%) resulted in no adverse impact," indicates that we are 95% confident that the true value is between 19% and 69%.

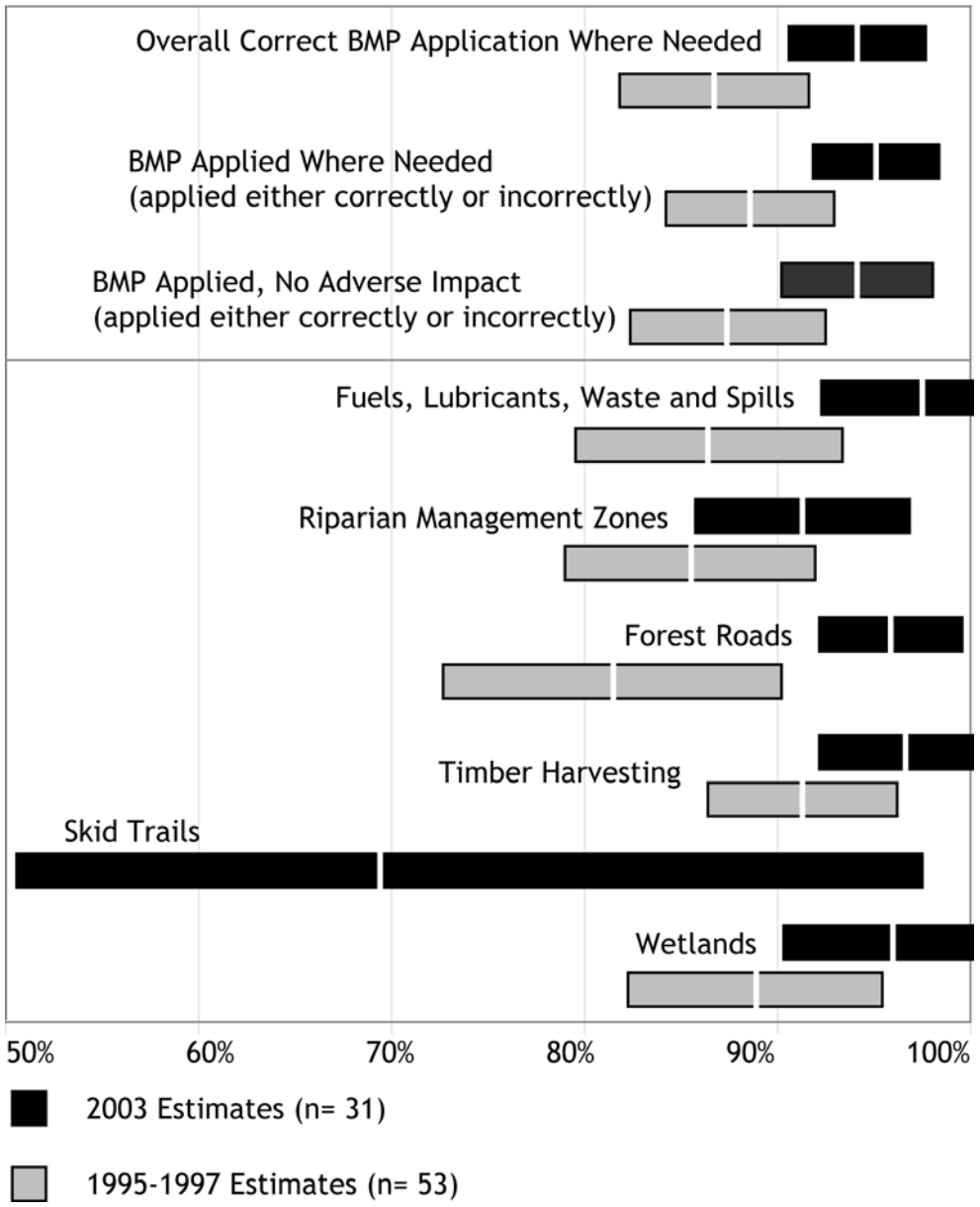


Figure 5: Various estimates and 95% confidence intervals of BMP application for county forest ownership, 1995-1997 *and* 2003.[†]

➲ Case Study

Lyannis Road Sale

The Lyannis Road timber sale, which borders the Wisconsin River, demonstrates the multiple benefits of riparian management zones. RMZs function as buffer strips for overland flow, absorb pollutants, provide critical habitat for riparian communities and regulate water temperature. They also provide a visual buffer between management activities and recreation corridors.

The Wisconsin River is the largest river in Wisconsin. It is a popular destination for recreation activates such as canoeing, fishing and bird watching. Prior to 2002, high winds disturbed many areas of the Northern Highland American Legion State Forest. The forest's management plan entailed salvaging wind thrown timber to prevent insect and disease outbreaks. The Lyannis Road timber sale was a quick and effective response.

Foresters and loggers worked to clean up the fallen trees while maintaining an RMZ and visual buffer to the Wisconsin River.

BMP Application on County Forest Ownership

Cumulative Reanalysis: 1995-1997

In order to infer the change in BMP application between the beginning of the BMP program and the current program, data from 1995-1997 were combined and analyzed for county forest ownership.

Fifty-three timber sales were sampled between 1995 and 1997 on county forest ownership. The mean overall correct application frequency (overall correct BMP application where needed) was 86% (± 5%). Various estimates for the 1995-1997 cumulative reanalysis are depicted in Figure 4 and Table 3.

Analysis: 2003

Data from the 2003 monitoring effort were analyzed for various estimates. A total of thirty-one timber sales were monitored in 2003.

The mean overall correct application frequency (overall correct BMP application where needed) was 93% (± 4%). Estimates for county forest lands are indicated in Figure 4 and Table 3.

Comparison of Results

All mean estimates for county forest ownership have increased since 1995-1997. There is a statistical difference ($p \leq 0.05$) between estimates for *forest roads*, 1995-1997 and 2003. No other differences are statistically significant.

BMP Application on State DNR Ownership

Cumulative Reanalysis: 1995-1997

In order to infer the change in BMP application between the beginning of the BMP program and the current program, data from 1995-1997 were also combined and analyzed for state DNR ownership.

Fifteen timber sales were sampled between 1995 and 1997. Because of the smaller sample size, confidence intervals were sometimes wider then desired. The mean overall correct application frequency (overall correct BMP application where needed) was 86% (± 8%). Various estimates for the 1995-1997 cumulative reanalysis are depicted in Table 4 and Figure 5.

Analysis: 2003

Data from the 2003 monitoring effort were analyzed for various estimates. A total of twenty-nine timber sales were monitored in 2003.

The mean overall correct application frequency (overall correct BMP application where needed) was 90% (± 4%). Estimates for state DNR lands are indicated in Table 4 and Figure 5.

Comparison of Results

Generally, mean estimates for state DNR ownership have increased since 1995-1997. No differences between time periods are statistically significant ($p > 0.05$).

Estimate	2003		1995-1997	
	%	±%	%	±%
Overall correct BMP application where needed	93	4	86	5
BMP applied where needed (either correctly or incorrectly)	95	3	88	4
BMP applied, no adverse impact	94	4	87	5
Fuels, lubricants, waste and spills	97	3	86	7
Riparian management zones	91	6	85	7
Forest roads	96	4	81	9
Timber harvesting	96	4	91	5
Skid trails	69	28	-	-
Wetlands	96	4	89	7

Table 3: Various estimates and half-width 95% confidence intervals of BMP application for county forest ownership, 1995-1997 *and* 2003. †

Estimate	2003		1995-1997	
	%	±%	%	±%
Overall correct BMP application where needed	90	4	86	8
BMP applied where needed (either correctly or incorrectly)	90	4	88	8
BMP applied, no adverse impact	89	4	87	8
Fuels, lubricants, waste and spills	97	3	88	12
Riparian management zones	96	3	78	16
Forest roads	71	13	79	15
Timber harvesting	99	1	98	2
Skid trails	78	14	-	-
Wetlands	91	7	93	7

Table 4: Various estimates and half-width 95% confidence intervals of BMP application for state DNR ownership, 1995-1997 *and* 2003. †

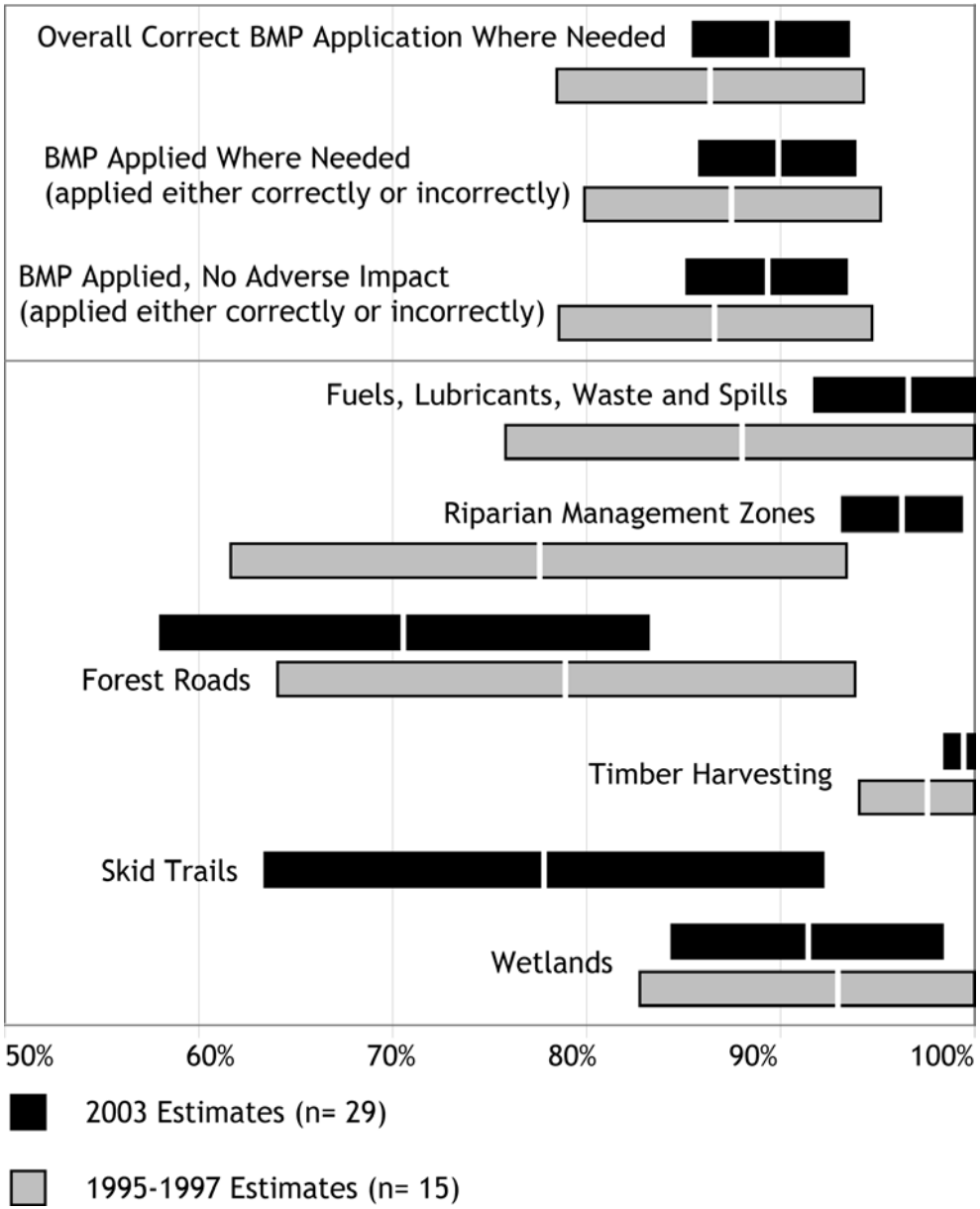


Figure 6: Various estimates and 95% confidence intervals of BMP application for state DNR ownership, 1995-1997 *and* 2003. †

Estimates for forest roads are low; applications most often resulted in major long-term impacts, 48% (± 36%, Table 6).

Regression and ANOVA Analyses of BMP Application: 2003

The samples used for the estimates calculated in Tables 3 and 4 were regressed upon latitude and longitude. ANOVA indicators were used to identify statistical differences between state regions. These analyses did not indicate any correlation between BMP application, spatial location or region.

Had these analyses indicated strong correlation or difference, regional outreach and education activates could have been planned or modified for regions with low BMP application.

BMP Effectiveness on County Forest and State DNR Ownership

Monitoring indicates that Wisconsin's current forestry BMPs are very effective at reducing non-point source pollution (Breunig, Gasser and Holland 2003). The Division of Forestry continues to collect effectiveness information to estimate the severity and duration of impacts resulting from incorrect or absent BMP application.

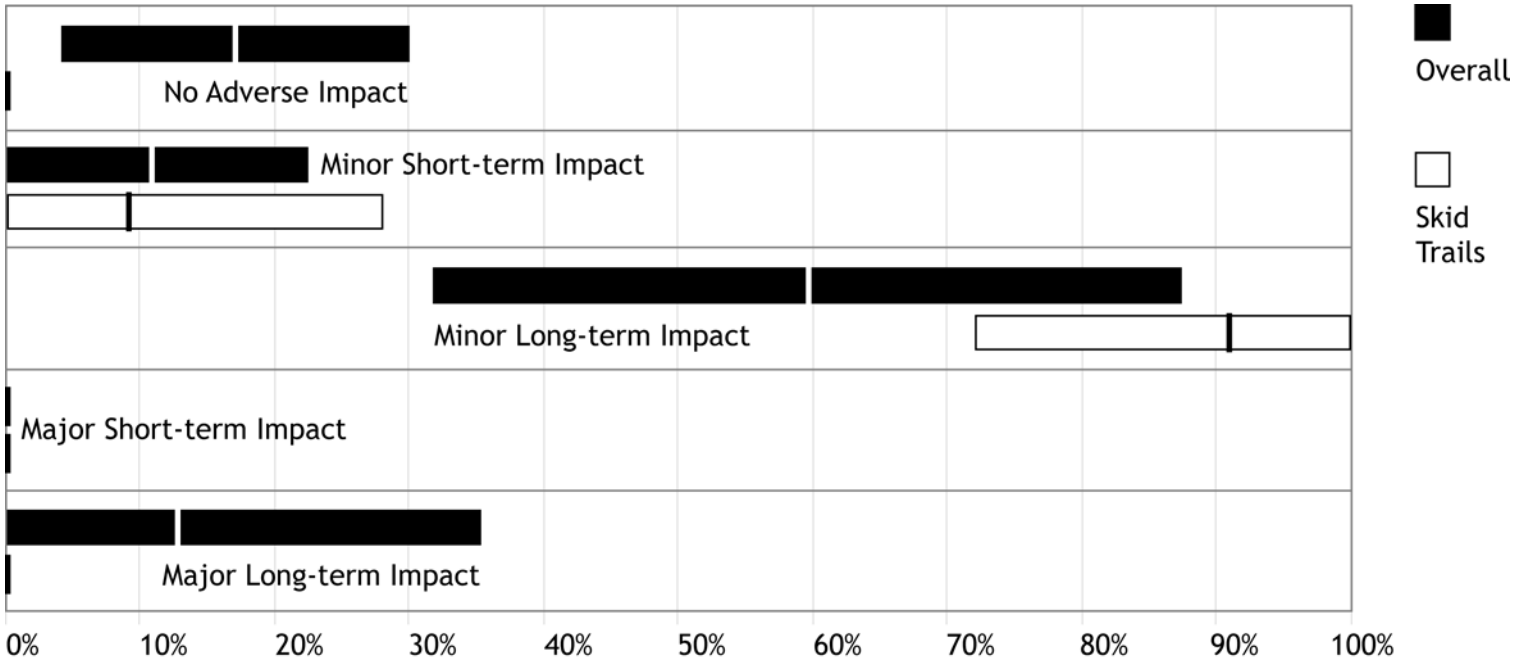


Figure 7: *Impact estimates and 95% confidence intervals for county forest ownership where BMPs were not applied, overall and* skid trails. †

BMP-Related Impacts on County Forest Ownership

When BMPs were applied correctly on county forest ownership, they proved to be 100% (± 0%) effective toward the elimination of adverse water quality impacts. When BMPs were applied incorrectly on county forest ownership, adverse water quality impacts were recorded for 100% (± 0%) of misapplications.

General BMP Absence, Water Quality Impacts

When BMPs were not applied where needed on county forest ownership, 83% (± 13%) resulted in adverse water quality impact; conversely, 17% (± 13%) of BMP absence resulted in no adverse impact.

When BMPs were not applied where needed on county forest ownership, most often minor long-term impacts occurred, 60% (± 28%). Overall impacts, measured across all BMP categories, are broken-down in Figure 6 and Table 5.

Skid Trail BMP Absence, Water Quality Impacts

The correct application rate for the *skid trails* BMP category is empirically lower than other categories. Closer examination of BMP absence reveals significant ($p \leq 0.05$) minor long-term water quality impacts: 91% (± 19%).

Impacts resulting from the absence of *skid trail* BMPs are broken-down in Figure 7 and Table 5.

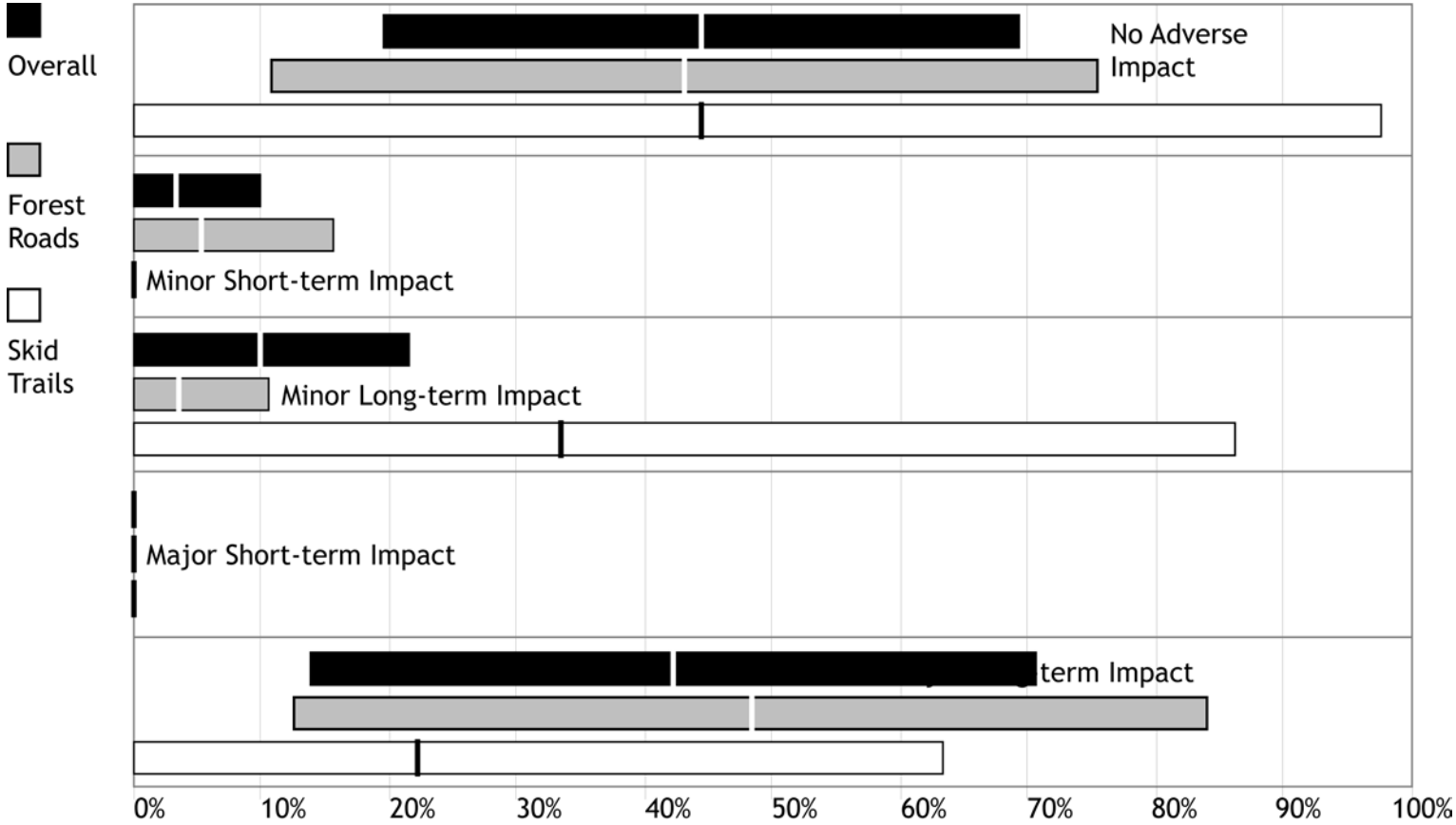


Figure 8: Impact estimates and 95% confidence intervals for state DNR ownership where BMPs were not applied - overall, forest roads *and* skid trails.[†]

BMP-Related Impacts on State DNR Ownership

When BMPs were applied correctly on state DNR ownership, they proved to be 100% (± 0%) effective toward the elimination of adverse water quality impacts. When BMPs were applied incorrectly on state DNR ownership, adverse water quality impacts were recorded for 100% (± 0%) of misapplications.

General BMP Absence, Water Quality Impacts

When BMPs were not applied where needed on state DNR ownership, 56% (± 25%) resulted in adverse impact; conversely, 44% (± 25%) of BMP absence resulted in no adverse impact.

When BMPs were not applied where needed on state DNR ownership, most often no adverse or major long-term impacts occurred, 44% (± 25%) and 42% (± 28%) respectively. Overall impacts,

measured across all BMP categories, are broken-down in Figure 8 and Table 6.

Forest Road BMP Absence, Water Quality Impacts

The correct application rate for the *forest roads* BMP category is empirically lower than most other categories. Closer examination of BMP absence reveals major long-term impacts: 48% (± 36%). Following major long-term impacts, BMP absence resulted in no adverse impact, 43% (± 32%).

Impacts resulting from the absence of *forest road* BMPs are broken-down in Figure 7 and Table 6.

Skid Trail BMP Absence, Water Quality Impacts

The correct application rate for the *skid trails* BMP category is also empirically lower than most other categories. Closer examination of BMP absence reveals long-term impacts: 56% (± 53%). Following long-term impacts, BMP absence resulted in no adverse impact, 44% (± 53%).

Impacts resulting from the absence of *skid trail* BMPs are broken-down in Figure 7 and Table 6.

Note:
† *Denotes that data represents timber sales where at least one acre of harvesting occurred on a wetland; was conducted within 200 feet of a lake river or stream; or a significant length of wetland was crossed.*

Type of Impact	Overall		Skid Trails	
	%	**±%**	**%**	**±%**
No adverse	17	13	0	0
Minor short-term	11	12	9	19
Minor long-term	60	28	91	19
Major short-term	0	0	0	0
Major long-term	13	23	0	0
Minor	70	29	100	0
Major	13	23	0	0
Short-term	21	23	18	38
Long-term	72	17	91	19

Table 5: Impact estimates and half-width 95% confidence intervals for county forest ownership where BMPs were not applied, overall and skid trails. †

Type of Impact	Overall		Forest Roads		Skid Trails	
	%	**±%**	**%**	**±%**	**%**	**±%**
No adverse	44	25	43	32	44	53
Minor short-term	3	7	5	11	0	0
Minor long-term	10	11	3	7	33	53
Major short-term	0	0	0	0	0	0
Major long-term	42	28	48	36	22	41
Minor	13	13	9	13	33	53
Major	42	28	48	36	22	41
Short-term	7	13	10	21	0	0
Long-term	52	26	52	34	56	53

Table 6: Impact estimates and half-width 95% confidence intervals for state DNR ownership where BMPs were not applied - overall, forest roads *and* skid trails. †

Discussion and Conclusion

Wisconsin is fortunate to have an effective and voluntary forestry BMP program. Principally, forestry BMPs are applied to protect water quality. Water quality BMPs are integrated into generally accepted silvicultral prescriptions as part of Wisconsin's new forest management guidelines (FMG). Undoubtedly, the new FMGs will amplify the correct and consistent application of water quality BMPs, especially on private ownership.

Since initial monitoring, BMP application on county forest and state DNR ownership has increased. It is clear that forestry BMPs are being applied with greater consistency than eight years ago.

Despite improvements in BMP application, desirable monitoring results should not preclude future monitoring on county forest and state DNR lands: It is essential to routinely monitor BMP application, so as to document the sustained effectiveness of our voluntary BMP program.

Additionally, monitoring may have future, unrealized benefits. Efficiencies and improvements might be realized: Future water quality monitoring could be integrated into FMG monitoring, in context similar to Minnesota's.

Aside from the future of Wisconsin's forestry BMP program, today it is apparent that county and state forestry professionals are doing a good job applying BMPs. Although monitoring results are favorable, additional improvements can be made.

➲ Case Study

Boomer Creek Sale

Iron County foresters actively manage thousands of acres of county forest land in Northern Wisconsin. Iron County contains many headwater streams that provide important habitat for sensitive aquatic species, such as trout.

The Boomer Creek timber sale area parallels a pristine coldwater creek and bounds several intermittent streams. Iron County foresters are aware of the potential sediment improperly constructed or maintained forest roads can contribute to waterways. Foresters and loggers cautiously designed and implemented 2,000 feet of new forest road for the timber sale.

Although no perennial streams were crossed, exposed soil particles had the potential to move into intermittent feeder streams and likewise Boomer Creek. Proper road placement, crowning, water diversion and cross drainage eliminated any visible sedimentation of Boomer Creek or its intermittent tributaries.

In particular, more consideration to *forest road* and *skid trail* BMPs should be paid in the future. Statistical comparisons between the estimated mean application and variation of and between BMPs indicate significant room for improvement: High, overall correct application rates (90-93%) with little variation (± 4%) compared to lower application rates (69-78%) with great variation (± 13-28%), exemplify the margin for improvement. Ultimately, it is the role of foresters and loggers to protect water quality by practicing *forest road* and *skid trail* BMPs where-needed.

With regard to BMP application and absence impacts, correct application is very important; their absence may significantly, durably affect water-quality on Wisconsin's landscape.

Ensuring the proper installation of appropriately sized culverts, water bars and diversion ditches reduces the potential for water quality degradation. Also important are: shaping and maintaining road surfaces, removing edge-berms created during road grading, regularly checking drainage structures and maintaining stream crossings. Retiring road surfaces with mulch and seed will reduce post-harvest erosion after the completion of forest management activities

It is also important to touch on the subject of water quality impacts. Previous BMP monitoring indicates that the majority of water quality impacts resulting from the absence of forestry BMPs are *major long-term* (Breunig, Gasser and Holland 2003). The monitoring conducted for this study indicates *long-term* impacts result from BMP absence. Therefore, *long-term* impacts are being consistently documented, indicating the extreme importance of BMP application.

Although observations of water quality impacts are subjective, they do bear creditability. Trained professionals and representatives from diverse interest groups collaborated to conclude water quality impacts. Peer-reviewed studies indicate a very strong correlation between BMP absence and quantifiable water-quality impacts.

With regard to BMP application and absence impacts, correct application is very important; their absence may significantly, durably affect water-quality on Wisconsin's landscape.

The next eight years of Wisconsin's Forestry BMPs for Water Quality program will reveal valuable, important information regarding BMP application. Additional landowner groups will prove their commitment to water quality through comprehensive, statistically-based sampling. The good people working on our county forests and DNR lands have led the initiative to cyclically monitor landowner groups.

Once up-to-date and statistically valid data have been collected, detailed spatial and temporal analyses will be feasible, new trends will be revealed, and additional educational opportunities will be identified. Monitoring will ensure the continued existence of Wisconsin's voluntary BMP program.

NOTE:
The Division of Forestry has previously published three monitoring reports (1995, 1997 and 2002). These free reports can be requested from the Division of Forestry by calling 608/267-7494 (Filbert, Holaday and Merryfield 1997; Cooper, Filbert and Holaday 1998).

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Appendix A: Monitoring Team Members

Northern Team, County Forest Ownership

Monitoring Dates: September 30, October 1 and 2

TL: Colleen Matula	DNR Forestry
EC: Phil Wallace	Trout Unlimited
FM: Greg Lake	International Paper
L: Curt Wester	Curt Wester Logging
S: Randy Gilberstson	NRCS
WQ: Bill Jaeger	DNR Water

Central Team, County Forest Ownership

Monitoring Dates: September 15, 16 and 17

TL: Brooke Ludwig	DNR Forestry
EC: Bill Schapfel	Jackson Bird Club, Izaak Walton League
FM: Tom Gjerde	Johnson Timber Company
L: Tim Davis	Trees R Us Logging
S: Butch Lobermeier	Price County LCD
WQ: Sara Eckardt	USDA Forest Service

North Central Team, County Forest Ownership

Monitoring Dates: September 10 and 11

TL: Jim Mineau	USDA Forest Service
EC: Patrick Goggin	Trout Unlimited
FM: Jim Warren	DNR Forestry
L: Ed Brandis	Timber Producers Association
S: Dave Hoppe	USDA Forest Service
WQ: Dale Lang	DNR Water

Private Contractor, State DNR Ownership

Monitoring Dates: November 7, 10, 12, 13, 18, 19, 20 April 6, 8, 13 and 19

WQ/S: Ann Michalski	Northern Environmental Consulting
EC: Barbra Richter	
FM: David Olson	Private Forester
L: Wayne Richter	Richter Logging

Key

TL: *team leader*	L: *logging*
EC: *environmental/ conservation*	S: *soils*
FM: *forest management*	WQ: *water quality*

Appendix B: Process Used for Updating Forestry BMP's

The Division of Forestry, in partnership with the BMP Advisory Committee, is responsible for conducting and completing BMP updating process.

Step 1. Solicit input from practitioners, landowners, and other interested groups (foresters, loggers, land managers, etc.) on BMPs that need updating. The BMP Advisory Committee will solicit input from represented constituencies. Suggest comments specify why the BMP is a concern and in need of updating (Solicit input via technical forums, training sessions, letters to individuals, etc.).

Step 2. Summarize input; request experts for a review of existing BMPs; provide summary of input gathered in Step 1 to experts to focus review. Request experts in their review to specifically identify:

a) Potential training and education needs.

b) Potential research needs.

c) BMPs to explore further on the need to update, modify or improve. Experts produce reports and/or analysis of review findings and recommend priority needs.

Step 3. BMP Advisory Committee evaluates experts' recommendations and confirms the following:

a) Potential training and education needs

b) Potential research needs

c) BMPs to explore further on the need to update, modify or improve.

Step 4. For those BMPs that are identified in Step 3.c. above, initiate the process to update, modify, or improve following public input and further analysis:

a) Provide general public information of BMP(s) proposed for revision/update.

b) Assemble team of experts and practitioners and have team draft the updates. (Experts to be drawn from sources such as SAF, University, USFS, Forest industry, environmental groups, loggers, land managing agencies, etc.)

c) Public review and comment.

d) Consideration of public and expert input.

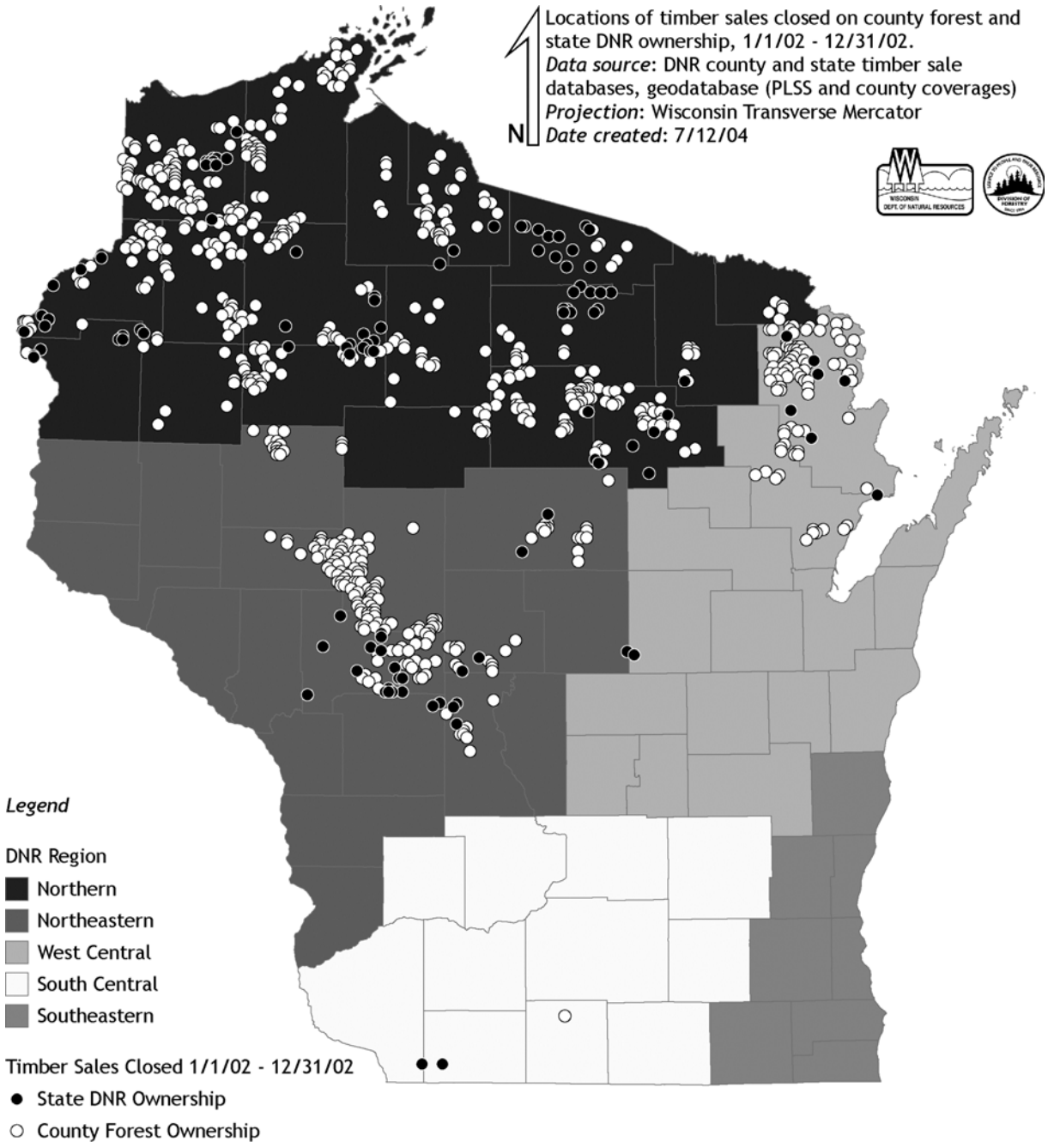
e) BMP Advisory Committee develops final report and recommendations to Chief State Forester.

f) Chief State Forester makes decision.

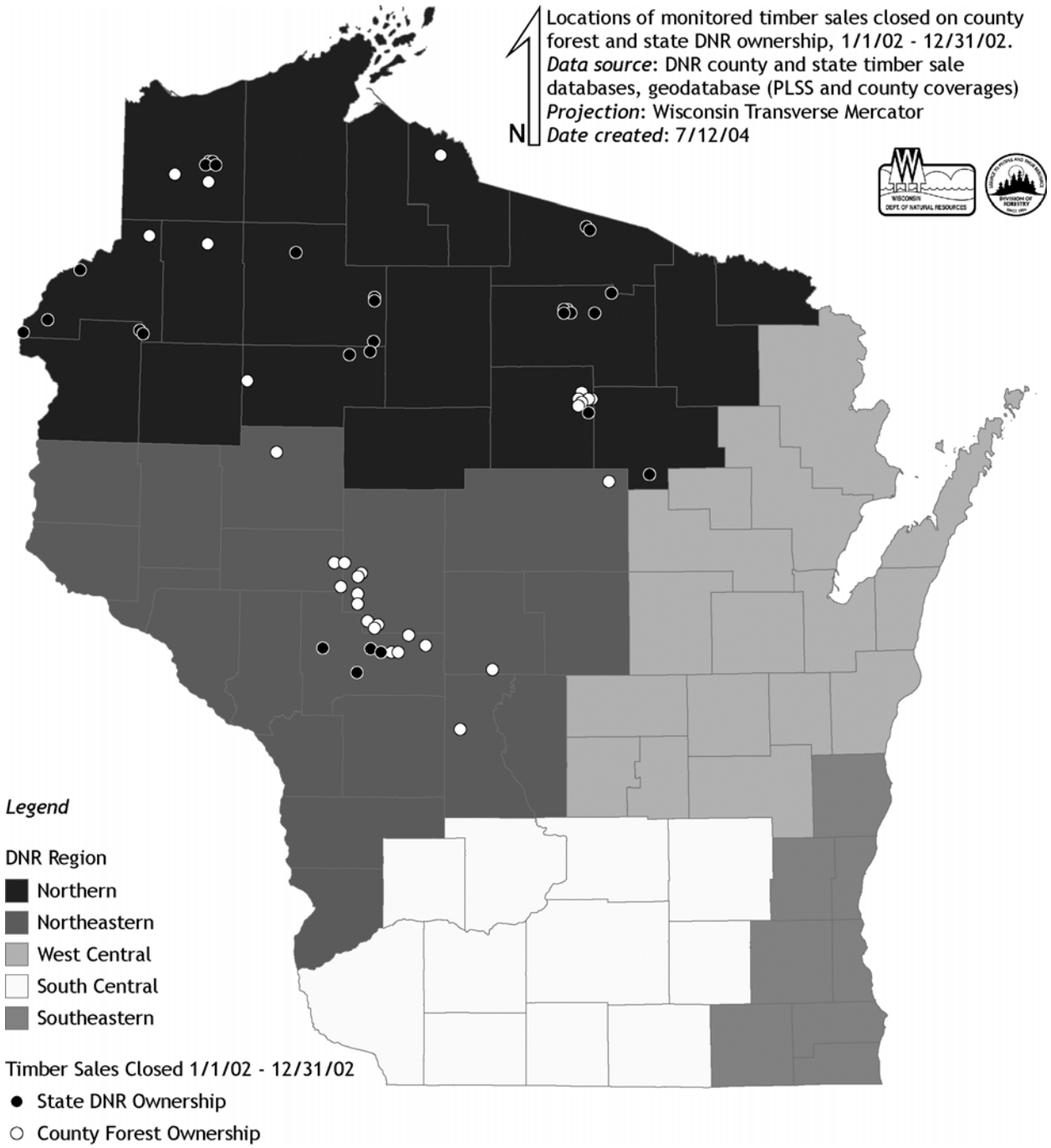
g) Formalize updates.

Step 5. Implement all BMPs (including those newly revised) and incorporate performance analysis into monitoring effort to determine why or why not BMPs are being implemented. Note: ongoing quantitative and qualitative analysis.

Appendix C: Locations of Timber Sales by Landowner Category



Appendix D: Locations of Timber Sales Monitored by Landowner Category



Appendix E: 2003 Monitoring Worksheet

2003 BMP Monitoring Worksheet

Monitoring Worksheet and Supplemental Questions for Wisconsin's Forestry Best Management Practices for Water Quality

Objectives of BMP Monitoring

1) Determine the extent to which BMPs were applied on the selected sites.
2) Determine the effectiveness of properly applied BMPs in protecting water quality on the selected sites.
3) Determine the effects of not applying BMPs where needed on the selected sites.
4) Examine the attitudes and concerns of private non-industrial landowners, concerning their timber sale, with emphasis on BMPs and riparian management (where applicable).
5) Obtain descriptive information about RMZs and buffer strips (where present) with respect to size, vegetative composition, and past use.

The results of these objectives from BMP Monitoring will be used to:

* Identify trends
* Identify where modifications may be needed in the BMP field manual
* Identify research and information needs
* Educate landowner, loggers and foresters involved in the sites that are monitored
* Compare and contrast with other regions of the state

Timber sale: _____

County: _____ Monitoring date: _____

Weather conditions: _____

Monitoring Team Members:

Name:	Affiliation:

APPLICATION 1 -- BMP applied correctly 2 -- BMP applied but incorrectly 3 -- BMP not applied 4 -- Insufficient information to rate X -- BMP not applicable to the site	EFFECTIVENESS 1 -- No adverse impact 2 -- Minor short-term impact 3 -- Minor long-term impact 4 -- Major short-term impact 5 -- Major long-term X -- Effectiveness rating not applicable		
BEST MANAGEMENT PRACTICES	**APPLICATION**	**EFFECTIVENESS**	**COMMENTS/IMPACT**
A. Fuels, Lubricants, Waste and Spills			
Fuels, Lubricants, and Waste (p. 13)			
Designate specific areas for equipment maintenance and fueling. Locate these areas on level terrain, a minimum of 100 feet from all streams and lakes.			
2. Collect all waste lubricants, containers, and trash (i.e. grease cartridges).			
B. Riparian Management Zones			
BMPs Common to All Three RMZ Categories (p. 18)			
3. Construct or use existing roads outside the RMZ, unless necessary for stream crossings.			
4. Construct or use existing landings outside the RMZ.			
5. Do not move slash into or pile slash within the RMZ. Keep slash out of lakes and stream channels and away from areas where it may be swept into the water.			
6. Minimize soil exposure and compaction to protect ground vegetation and the duff layer.			
BMPs for Lakes and Navigable Perennial Streams (100' wide RMZ) (p. 19)			
7. Do not operate wheeled or tracked harvesting equipment within 50 feet of the ordinary high-water mark except on roads or at stream crossings.			
8. Use selective harvesting and promote long-lived tree species appropriate to the site: i.e. sugar/red maple, oaks, white/black ash, hemlock, white/red pine & white cedar.			
9. Harvesting intervals should be no more frequent than every 10 years.			
10. Do not reduce basal area below 60 ft2 per acre in trees 5-inches DBH and larger, evenly distributed.			
11. Develop trees 12-inches DBH and larger.			
BMPs for Navigable Intermittent Streams (35' wide RMZ) (p. 20)			
12. Operate wheeled or tracked harvesting equipment within 15 feet of the ordinary high-water mark only when the ground is frozen or dry.			
13. Use selective harvesting and promote long-lived tree species appropriate to the site.			
14. Harvesting intervals should be no more frequent than every 10 years.			
15. Do not reduce basal area below 60 ft2 per acre in trees 5-inches DBH and larger, evenly distributed.			

APPLICATION 1 -- BMP applied correctly 2 -- BMP applied but incorrectly 3 -- BMP not applied 4 -- Insufficient information to rate X -- BMP not applicable to the site	EFFECTIVENESS 1 -- No adverse impact 2 -- Minor short-term impact 3 -- Minor long-term impact 4 -- Major short-term impact 5 -- Major long-term X -- Effectiveness rating not applicable		
BEST MANAGEMENT PRACTICES	**APPLICATION**	**EFFECTIVENESS**	**COMMENTS/IMPACT**
B. Riparian Management Zones (continued)			
BMPs for Non-Navigable Streams (35' wide RMZ) (p. 20)			
16. Operate wheeled or tracked harvesting equipment within 15 feet of the ordinary high-water mark only when the ground is frozen or dry.			
C. Forest Roads			
Planning, Location and Design of Forest Roads (p. 22)			
17. Use existing roads when they provide the best long-term access. Consider relocating existing roads if doing so improves access and reduces environmental impacts.			
18. Plan road systems that minimize the number, width, and length of roads to limit the total area of the site disturbed.			
19. Select road locations that allow for drainage away from the road.			
20. Where possible, locate roads on well-drained soils.			
21. If road grades > 10% are necessary, limit grade length or break the grade using drainage structures.			
22. Construct roads to follow natural contours and minimize cut and fills. Balance cut and fills to minimize the need for fill or removing excess materials.			
Stream Crossing Design and Construction (p. 23)			
General BMPs for Stream Crossings on Haul Roads (pp. 23-25)			
23. Minimize the number of stream crossings.			
24. Identify optimum stream-crossing locations: straight and narrow stream channels; low banks; firm rocky soil; keep approaches at the least gradient possible.			
25. Design, construct, and maintain stream crossings to avoid disrupting the migration/movement of aquatic life.			
26. Install stream crossings using materials that are clean, non-erodible, and non-toxic to aquatic life.			
27. Install stream-crossing structures at right angles to the stream channel.			
28. Minimize channel changes and the amount of excavation or fill needed at the crossing.			
29. Limit construction activity in the water to periods of low or normal flow. *Check harvest dates.			
30. Keep use of equipment in the stream to a minimum.			
31. Construct a bridge or place fill directly over a culvert			

APPLICATION 1 -- BMP applied correctly 2 -- BMP applied but incorrectly 3 -- BMP not applied 4 -- Insufficient information to rate X -- BMP not applicable to the site	EFFECTIVENESS 1 -- No adverse impact 2 -- Minor short-term impact 3 -- Minor long-term impact 4 -- Major short-term impact 5 -- Major long-term X -- Effectiveness rating not applicable

BEST MANAGEMENT PRACTICES	APPLICATION	EFFECTIVENESS	COMMENTS/IMPACT
C. Forest Roads (continued)			
General BMPs for Stream Crossings on Haul Roads (pp. 23-25) (continued)			
32. Divert road drainage into undisturbed vegetation, so that the drainage does not directly enter the stream.			
33. Stabilize approaches to bridge, culvert, and ford crossings with aggregate or other suitable material.			
34. Anchor temporary structures on one end with a cable or other device so they do not float away during high water.			
Pipe Culverts for Stream Crossings on Haul Roads (pp. 25-27)			
35. Install pipe culverts long enough so road fill does not extend beyond the ends of the culvert.			
36. Install permanent culverts that have a minimum diameter of 12 inches.			
37. Install culverts so there is no change in the stream bottom elevation. Culverts should not cause damming or pooling.			
38. Cover the top of culverts with fill to a depth of 1/3 of the pipe diameter or at least 12 inches, whichever is greater.			
39. Use riprap around the inlet of culverts. For permanent installations, use filter fabric under the riprap.			
40. Keep culverts clear and free of debris.			
Fords for Stream Crossings on Haul Roads (p. 27)			
41. Locate fords where streambanks are low.			
42. Streambed should have a firm rock or gravel base. If not, install stabilizing material such as reinforced concrete planks, crushed rock, riprap, or rubber mats on streambeds.			
Road Construction/Reconstruction and Drainage (pp. 28 and 29)			
43. Construct roads to remove water from road surfaces:			
(a) Crowned			
(b) Outsloped			
(c) Insloped with ditches and cross drainage.			
44. Construct stable cut and fill slopes that will revegetate easily, either naturally or artificially.			
45. Do not bury debris in the road base.			
46. Surface the road with gravel where steep grades, erodible soils, or high-traffic volume make the potential for surface erosion significant.			

APPLICATION 1 -- BMP applied correctly 2 -- BMP applied but incorrectly 3 -- BMP not applied 4 -- Insufficient information to rate X -- BMP not applicable to the site	EFFECTIVENESS 1 -- No adverse impact 2 -- Minor short-term impact 3 -- Minor long-term impact 4 -- Major short-term impact 5 -- Major long-term X -- Effectiveness rating not applicable		
BEST MANAGEMENT PRACTICES	**APPLICATION**	**EFFECTIVENESS**	**COMMENTS/IMPACT**
C. Forest Roads (continued)			
Drainage Structures (p.29)			
Pipe Culverts for Cross Drains on Haul Roads (pp. 30-31)			
47. Install pipe culverts to provide cross drainage on road grades at recommended intervals (Table 6-1,p. 29) immediately above steep grades, below bank seepages, and where water will run onto log landings or forest roads.			
48. Install pipe culverts long enough so road fill does not extend beyond the end of a culvert.			
49. Install pipe culverts at grades at least 2% more than the ditch grade and angled 30-45º to improve inlet efficiency (Figure 6-9).			
50. Select the size of cross-drain culverts according to the size of the road and area drained by the ditch. Permanent culverts should be 12-inch minimum diameter.			
51. Cover the top of the culvert with fill to a depth of 1/3 of the pipe diameter or at least 12 inches, whichever is greater.			
52. Use riprap around the inlet of culverts to prevent water from eroding and undercutting the culvert.			
Open-Top Culverts for Cross Drains on Haul Roads (p. 31)			
53. Open-top culverts should be installed only on seasonal or temporary roads.			
54. Install open-top culverts to provide cross drainage immediately above steep grades, below bank seepages, where water will run onto log landings or forest roads, and on road grades at recommended intervals (Table 6-1, p. 29).			
55. Clean open-top culverts frequently.			
Broad-Based Dips for Cross Drains on Haul Roads (p. 32)			
56. Install broad-based dips where necessary to provide cross drainage and road-surface drainage for roads with a gradient of 15% or less.			
57. Construct broad-based dips deep enough to provide adequate drainage and wide enough to allow trucks and equipment to pass safely.			
58. Place a surface of crushed stone or gravel on the dip and mound for soils and conditions where rutting may occur.			
Water Bars for Cross Drains on Haul Roads (p. 33)			
59. Install water bars where necessary to provide cross drainage and road surface drainage.			
60. Place water bars at a 30-45º angle with a cross drainage grade of 2%.			

APPLICATION 1 -- BMP applied correctly 2 -- BMP applied but incorrectly 3 -- BMP not applied 4 -- Insufficient information to rate X -- BMP not applicable to the site	EFFECTIVENESS 1 -- No adverse impact 2 -- Minor short-term impact 3 -- Minor long-term impact 4 -- Major short-term impact 5 -- Major long-term X -- Effectiveness rating not applicable

BEST MANAGEMENT PRACTICES	APPLICATION	EFFECTIVENESS	COMMENTS/IMPACT
C. Forest Roads (continued)			
Diversion Structures for Haul Roads (p. 33, figure on page 25)			
61. Install diversion ditches where necessary to divert runoff away from roads and side ditches and channel it into vegetation before the runoff enters a stream, lake or wetland.			
62. Construct diversion ditches so they intersect the roadside ditch at the same depth and are outsloped 1-3% (Figure 6-4).			
Soil Stabilization (p.34)			
Mulching and Seeding (p.34)			
63. Use mulch and/or seed where necessary to minimize soil erosion into streams, lakes, and wetlands.			
Sediment Control Structures (pp. 35 and 36)			
64. Install sediment control structures where necessary to slow runoff and trap sediment until vegetation is established at the sediment source:			
(a) silt fencing for sheet flow.			
(b) straw bales for sheet and channelized flow.			
65. Maintain, clean, or replace sediment-control structures until areas of exposed soil are stabilized.			
Road Maintenance (p. 37)			
Active Roads (p. 37)			
66. Clear debris from drainage structures. Place the debris where it cannot be washed back into these structures or into open water.			
67. Keep traffic to a minimum during wet periods and spring breakup.			
68. Shape road surfaces periodically to maintain proper surface drainage. Fill in ruts and holes with gravel or compacted fill as soon as possible.			
69. Remove berms along the edge of the road if they will trap water on the road.			
70. When dust control agents are used, apply them in a manner that will keep these compounds from entering lakes, streams and groundwater.			

APPLICATION 1 -- BMP applied correctly 2 -- BMP applied but incorrectly 3 -- BMP not applied 4 -- Insufficient information to rate X -- BMP not applicable to the site	**EFFECTIVENESS** 1 -- No adverse impact 2 -- Minor short-term impact 3 -- Minor long-term impact 4 -- Major short-term impact 5 -- Major long-term X -- Effectiveness rating not applicable		
BEST MANAGEMENT PRACTICES	**APPLICATION**	**EFFECTIVENESS**	**COMMENTS/IMPACT**
C. Forest Roads (continued)			
Inactive Roads (p. 37)			
71. Remove all temporary drainage and stream crossing structures.			
72. Shape all road system surfaces to maintain proper surface drainage, if necessary.			
73. Inspect and maintain road surfaces, permanent drainage and stream-crossing structures (ditches, culverts, bridges, etc.)			
D. Timber Harvesting - Uplands only, not on wetlands			
Planning (p. 38)			
74. Limit the length and number of skid trails, and the number of landings and stream crossings.			
Harvesting (pp. 38-39)			
75. Whenever possible, winch logs from steep slopes if skidding could cause erosion that affects water quality.			
76. Avoid operating equipment where excessive soil compaction and rutting occurs.			
77. Do not pile slash into drainage areas where runoff may wash slash into streams, lakes, or wetlands.			
Landings (p. 39)			
78. Use existing landings if possible.			
79. Close existing landings in RMZs unless construction of new landings will cause greater harm to water quality than using existing landings.			
80. Locate landings outside RMZs.			
81. Locate landings on frozen ground or on firm well-drained soils with a slight slope, or on ground shaped to promote drainage.			
82. Locate residue piles (sawdust, field chipping residue, cull logs, etc.) away from drainages where runoff may wash residue into streams, lakes or wetlands.			
83. To prevent erosion and sedimentation into surface water, do the following where needed:			
(a) Fill in ruts			
(b) Seed and mulch			
(c) Install sediment control structures			

APPLICATION 1 -- BMP applied correctly 2 -- BMP applied but incorrectly 3 -- BMP not applied 4 -- Insufficient information to rate X -- BMP not applicable to the site	EFFECTIVENESS 1 -- No adverse impact 2 -- Minor short-term impact 3 -- Minor long-term impact 4 -- Major short-term impact 5 -- Major long-term X -- Effectiveness rating not applicable		
BEST MANAGEMENT PRACTICES	**APPLICATION**	**EFFECTIVENESS**	**COMMENTS/IMPACT**
D. Timber Harvesting - Uplands only, not on wetlands (continued)			
Skid Trails (p. 39)			
84. Where possible, keep skid trail grades < 15%. Where steep grades are unavoidable, break the grade and install drainage structures at recommended intervals (Table 6-1, p.29). Grades > 15% should not exceed 300 feet in length.			
85. To prevent erosion and sedimentation into surface water, do the following where needed:			
(a) Fill in ruts			
(b) Seed and mulch			
(c) Install sediment control structures			
General BMPs for Stream Crossings on Skid Trails (p. 23-25, 40)			
86. Minimize the number of stream crossings.			
87. Identify optimum stream-crossing locations: straight and narrow channels; low banks; firm rocky soil; keep approaches at the least gradient possible.			
88. Design, construct, and maintain stream crossings to avoid disrupting migration/movement of aquatic life.			
89. Install stream crossings using materials that are clean, non-erodible and non-toxic to aquatic life.			
90. Install stream-crossing structures at right angles to the stream channel.			
91. Minimize channel changes and the amount of excavation or fill needed at the crossing.			
92. Limit construction activity in the water to periods of low or normal flow. *Check harvest dates.			
93. Keep use of equipment in the stream to a minimum.			
94. Construct a bridge or place fill directly over a culvert higher than the trail approach to prevent surface road runoff from draining onto the crossing structure and into the stream.			
95. Divert trail drainage into undisturbed vegetation, so that the drainage does not directly enter the stream.			
96. Stabilize approaches to bridge, culvert, and ford crossings with aggregate or other suitable material.			
97. Anchor temporary structures on one end with a cable or other device so they do not float away during high water.			
Pipe Culverts for Stream Crossings on Skid Trials (pp.25-27)			
98. Install pipe culverts long enough so fill does not extend			

APPLICATION 1 -- BMP applied correctly 2 -- BMP applied but incorrectly 3 -- BMP not applied 4 -- Insufficient information to rate X -- BMP not applicable to the site	EFFECTIVENESS 1 -- No adverse impact 2 -- Minor short-term impact 3 -- Minor long-term impact 4 -- Major short-term impact 5 -- Major long-term X -- Effectiveness rating not applicable

BEST MANAGEMENT PRACTICES	APPLICATION	EFFECTIVENESS	COMMENTS/IMPACT
D. Timber Harvesting - Uplands only, not on wetlands (continued)			
Pipe Culverts for Stream Crossings on Skid Trials (pp.25-27) (continued)			
100. Install culverts so there is no change in the stream bottom elevation.			
101. Cover the top of culverts with fill to a depth of 1/3 of the pipe diameter or at least 12 inches, whichever is greater.			
102. Use riprap around the inlet of culverts. For permanent installations, use filter fabric under the riprap.			
103. Keep culverts clear and free of debris.			
Fords for Stream Crossings on Skid Trails (p. 27)			
104. Use fords for crossing dry streambeds or where fording minimizes water quality impacts.			
105. Locate fords where streambanks are low.			
106. Streambed should have a firm rock or gravel base. If not, install stabilizing material such as reinforced concrete planks, crushed rock, riprap, or rubber mats on streambeds.			
107. Pole fords must be removed immediately after use or before the upstream end becomes clogged with debris and impedes streamflow.			
108. E. Wetlands			
General BMPs/Planning (p. 47)			
109. Whenever practical, avoid constructing roads and landings in wetlands; otherwise use extreme caution.			
110. Forest management activities in wetlands should occur on firm ground (frozen or dry).			
NOTE: Put in the comments: (a) the slash was pushed into the wetland from an upland; or (b) trees were felled into the wetland and slash was left in the wetland - "some" slash left in a wetland is not a problem.			
111. Do not move slash from upland sites into a wetland.			
112. Keep slash out of open water.			
113. Avoid equipment maintenance and fueling in wetlands.			
Roads, Skid Trails, and Landings (p. 48)			
114. Construct upland road and trail approaches to wetlands so that surface runoff is diverted away from the road so the runoff does not enter the wetland.			
115. If landings are necessary in a wetland, build them to the minimum size required for the operation.			
116. Avoid operating equipment in areas of open water, springs or seeps.			
117. Provide for adequate cross-road drainage to minimize			

APPLICATION 1 -- BMP applied correctly 2 -- BMP applied but incorrectly 3 -- BMP not applied 4 -- Insufficient information to rate X -- BMP not applicable to the site	EFFECTIVENESS 1 -- No adverse impact 2 -- Minor short-term impact 3 -- Minor long-term impact 4 -- Major short-term impact 5 -- Major long-term X -- Effectiveness rating not applicable		
BEST MANAGEMENT PRACTICES	**APPLICATION**	**EFFECTIVENESS**	**COMMENTS/IMPACT**
D. Timber Harvesting - Uplands only, not on wetlands (continued)			
Roads, Skid Trails, and Landings (p. 48) (continued)			
118. For permanent fill roads, install culverts or bridges a maximum of 300 feet apart and at all natural drainageways. Install at least one drainage structure at each wetland crossing.			
119. For temporary roads, provide adequate cross-road drainage at all natural drainageways. Temporary drainage structures include culverts, bridges, and porous material such as corduroy or chunkwood. Temporary non-organic structures, such as metal culverts and bridges, should be removed when work is complete.			
120. Cease equipment operations when rutting becomes excessive.			
121. If necessary, use low ground pressure equipment to minimize rutting.			
122. If necessary, use corduroy, chunkwood, or rubber mats to improve the soil's ability to support traffic.			

Appendix F: Guidelines for Monitoring Teams

Guidelines for BMP Monitoring Teams – 2003

For Wisconsin's Forestry Best Management Practices for Water Quality Program

1. For "Application" rating "0" or "4", use "Effectiveness" rating "0 – Effectiveness rating not applicable".
2. When rating the effectiveness of a BMP with a "minor" or major" impact, be sure to provide notes in the "Comments" column on items such as quantity and duration, distance to the water resource, and the type of water resource.
3. If a BMP is being rated along more than one water resource (i.e. along two streams), the team should use their professional judgment and provide an average application and effectiveness rating for the BMP. Again, be sure to include important information about your decision in the "Comments" column next to the BMP.
4. If you suspect a BMP is or was needed, only rate a BMP that you can see or have reliable information about; otherwise, use "Application" rating "4 – Insufficient information to rate".
5. Where feasible, evaluate the entire timber sale, even though portions of the sale (a) may not be on a wetland or (b) may be greater than 200 feet from a stream or lake. Fore large sales, time constraints will make it essential for the team to concentrate on areas with the greatest impact to water quality (such as on wetlands, along streams and lakes, and on forest roads).
6. In a situation where a portion of a road, skid trail, or other activity on a sale causes erosion but the runoff does not drain towards a surface water feature, the BMP "Application" rating is still applicable to the site and should be evaluated. The "Application" rating will either be "1-BMP applied correctly", "2 - BMP applied but incorrectly", or "3 - BMP not applied". In these cases, the BMP "Effectiveness" rating would be "1 - No adverse impact" since there is no potential impact to water quality.
7. Audit only the length of haul road constructed or reconstructed for the timber sale, regardless of whether the haul road is within or outside of the timber sale boundary. If an existing road is used without reconstruction, the road maintenance BMPs are still applicable to this road and should be evaluated on the worksheet.
8. Audit any stream crossing that was installed to access the timber sale even if it's located outside of the timber sale boundary. If an existing stream crossing was used to access the timber sale, the BMPs for stream crossing maintenance are still applicable and should be evaluated on the worksheet.

1. Active Roads are those that continue to be used by the landowner(s) and or public for multiple uses, including forest management, hunting, and recreation. Inactive Roads are those that are closed by berms, boulders, pits, or other measures that make vehicle passage most unlikely.
2. Evaluate the site only for forest activities or roads used by the logger in 2002-2003.
3. When evaluating Wisconsin DNR lands, DNR team members can help rate the timber sale, but can not be the team recorder for the sale.
4. Any person who set-up and/or administered the timber sale (including DNR personnel) should not participate in rating the sale, except to answer questions from team members about the sale.
5. For each timber sale, one audit worksheet should be completed and written *in pen* by one team member (cross out any changes and do not erase information). Everyone on a team should have an opportunity to be the "team recorder" for at least one timber sale during the week of monitoring.
6. People who are not monitoring team members are welcome to observe the teams, but they (a) must pay for their own expenses and (b) can not rate BMPs. Only the 2003 BMP Monitoring Team members can rate BMPs.
7. Mark a waypoint:
   a) Where you park your vehicles.
   b) Where ever you identify a landing, stream crossing, or wetland corssing.
   c) When you note a long-term or major impact on the monitoring worksheet.
   d) Where a picture is taken.
8. Remember:
   a) We are evaluating BMPs and activities that may impact water quality, aquatic ecosystems, fish and other aquatic life. We are not rating aesthetics.
   b) Information from this monitoring will help us improve the BMP manual as well as education and training workshops. Do not try to rate something that is not in the BMP field manual, but feel free to make notes on how we can improve the manual or our educational efforts.
   c) We are not rating fault. We are simply rating existing conditions.
   d) Thanks for your help and have fun.

Appendix G: Bias and Limitations of the Monitoring Methodology

- There were many situations that made it difficult to determine if a sale met the monitoring criteria or not. For instance, some timber sales were harvested over a period of time, such as three consecutive years. When only one part of the sale was near a water feature, sometimes it was difficult to determine if that part was harvested the previous year, in which case it met the criteria; or two or three years earlier, in which case it did not meet the criteria.

- On occasion, foresters deliberately identified a "no-cut" zone of greater than 200 feet next to a stream. These timber sales did not meet our monitoring criteria, yet these were exceptional timber sales with respect to identifying a riparian management zone and protecting water quality.

- Conversely, a "no-cut" zone may have been purposefully designed to be narrower than the recommended width. The product of a valid management objective, this narrow zone was misread by monitoring team members. Lower than normal scores for some BMPs may have been recorded.

- Because teams monitored timber sales up to 28 months after completion of the harvest, extensive ground cover may have been present which made observations of ground conditions difficult. As a result, evidence of water quality impacts that may have occurred shortly after harvest may not have been detected.

- Similar to the previous limitation, snow cover may have been a factor.

- Whether or not a BMP was needed, and therefore rated, on a site often depended on the water resource(s) on the site. The water resources are legally defined in Wisconsin as a "stream, lake or wetland." Despite moderate training on the subject during the July workshop, teams sometimes had a difficult time determining (1) the difference between a lake and a wetland with standing water in it and (2) the difference between navigable and non-navigable streams. As a result, some BMPs may have been rated where they should not have, while others may not have been rated when applicable.

- Monitoring team members commented that there were situations when they were not sure if they should use an application rating of (0) *BMP not applicable* to the site or (4) *insufficient information to rate*. However, this did not affect application ratings 1, 2 and 3.

- Rating timber sales for effectiveness was accomplished using a point-in-time qualitative visual observation of the site, most often looking for signs of erosion and sedimentation. Since this qualitative evaluation was not as precise as a more expensive quantitative evaluation, there may have been some differences in the ratings among the monitoring teams. Nevertheless, the methodology used provided valuable analysis of the use and effectiveness of BMPs in a cost-effective manner.

Although the definitions for the minor and major effectiveness ratings were defined, a range of interpretation between the teams still existed. In continuance with the 2003 training workshop, future monitoring will focus on defining the effectiveness ratings using enhanced examples and explanation.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